Summaries

UDC 514.76

Ivlev E.T., Pshenichnikova A.S., Pilipenko V.A.
ON INVARIANT FIELD OF TWO-DIMENSIONAL DISTRIBUTION AREAS OF MULTIDIMENSIONAL PLANES IN EUCLIDEAN SPACE

Fields of pairs of corresponding two-dimensional areas of m-planes and normal ($n-m$)-distribution planes $\Delta^1_{n,m}$ in Euclidean space E_n have been studied.

UDC 519.2

Kitaeva A.V., Koshkin G.M.
SEMIRECCURENT NUCLEAR ESTIMATIONS OF BASIC FUNCTIONALS BY INDEPENDENT OBSERVATIONS

Substitution estimations for wide class of functionals from multidimensional distribution densities containing functionals from conditional distribution have been considered. Recurrent nuclear estimations with vector blur parameter (basic functional estimations) are suggested as the elements of substitution. The main part of asymptotic average squared error of basic functional estimation is found. It is shown that in asymptotic at optimal choice of blur parameters the unlimited approach of convergence rate in average squared of suggested nonparametric and common parametric estimations may be achieved by nucleus selection.

UDC 517.968

Tabyshov R., Narmatova M.Zh.
SOLUTION OF PARTIAL INTEGRO-DIFFERENTIAL EQUATIONS BY AUTOCONTROL OF BARBASHIN TYPE

Approximate solution of partial integro-differential equations with autocontrol of Barbashin type is made by the method of oscillating functions, the convergence of made process is proved.

UDC 517.3

Churikov V.A.
FRACTIONAL ANALYSIS ON THE BASIS OF HADAMARD OPERATOR

The possibility of construction on the basis of Hadamard operator the analysis in which derivative and integral orders may possess any finite real values has been shown. Properties of Hadamard operator were considered. General exponent for any orders of integration and differentiation with the help of Hadamard operator was obtained. Formulas for generalization of trigonometric and hyperbolic functions within the bounds of the developed fractional analysis were suggested.

UDC 517.3

Churikov V.A.
FRACTIONAL ANALYSIS OF 1/2 ORDER ON THE BASIS HADAMAR APPROACH

Exponents, trigonometric and hyperbolic functions in fractional analysis of 1/2 order have been considered. Diagrams of the given functions are given.

UDC 621.833

Yangulov V.S.
GEOMETRIC AND CONSTRUCTIVE RATIOS IN WAVE GEARS WITH INTERMEDIATE SOLIDS OF REVOLUTION

The procedure of calculation of geometric and constructive ratios of wave gears with intermediate solids of revolution has been presented. The technique of geometric calculation of gears with adaptive generator was suggested and the influence of errors of elements production on input function was determined.

UDC 621.833

Yangulov V.S.
FORCE DESIGN OF WAVE GEARS WITH INTERMEDIATE SOLIDS OF REVOLUTION WITH ADAPTIVE GENERATOR

The design techniques have been given: stresses in contacts of intermediate solids of revolution of wave gears with elastic tightness in locking; relative velocities in contact of gear elements; powers of friction losses in locking.

UDC 621.039.532.21

Tsyganov A.A., Savinykh P.G., Komarov E.A., Kotlyarevsky S.G., Pavlyuk A.O., Shamanin I.V., Nesterov V.N.
STORED ENERGY IN GRAPHITE OF STACKING OF SHUT-DOWN INDUSTRIAL URANIUM-GRAPHITE REACTORS

Temperature value for graphite of the most "dangerous" elements of graphite stacking at industrial uranium-graphite reactor I-1 (upper bushings of working cells and cells of control and protection systems and enriched metal) up to which their warming is possible due to self-sustained extraction of stored energy has been conservatively estimated. Its value exceeded considerably the temperature of graphite combustion (700 °C). The realization of conditions for which the design was made is of negligibly small probability in practice. It was stated that for complete exclusion of self-sustained extraction of stored energy one can recommend to extract from the stacking of industrial uranium-graphite reactor I-1 the upper 2–3 bushings from working cells and completely bushing assemblies from the cells of control and protection systems and enriched metal.

UDC 621.039.519.2

Shutikov A.V., Savchenko V.E., Vigranenko Yu. M., Khrustalev V.A.
WAYS OF IMPROVEMENT OF WATER CHEMISTRY OF NPP SECONDARY COOLANT CIRCUIT WITH VVER-1000

It has been shown that correction of secondary coolant circuit operating environment with ethanolamine carried out along with other procedures may decrease significantly the corrosion damage process in steam generator results in increasing heat-generation in it and possibility of VVER-1000 reactor operation at advanced power level.

UDC 536.46

Koshelev K.B.
STUDYING THE PROCESS OF STRUCTURE FORMATION AND SELF-HEATING IN BINARY POWDER MIXTURE Ti-Al IN THE MODE OF STATIC THERMAL EXPLOSION ON THE BASIS OF STATE DIAGRAM

On the basis of equilibrium state diagram of the mixture Ti-Al mathematical model of phase formation processes in the mode of static thermal explosion of powder mixture at temperatures increasing melting temperature of fusible component has been developed. Thermograms of self-heating process were obtained; the dynamic of structure formation processes using the methods numerical simulation for stoichiometry of compounds $TiAl_3$ и TiAl was studied. It was shown that the results of calculations reveal satisfactory qualitative coincidence with the experimental data.

UDC 539.194

Stroynova V.N., Emelyanov D.S.
APPLICATION OF PADE-BOREL CONVERSION FOR CALCULATING RELAXATION PARAMETERS OF MOLECULE H_2O LINES

The model using Pade-Borel conversion for improving convergence of perturbation theory series in the effective Hamiltonian method has been presented. The model was applied for calculating half-width

and shift of line centers of water vapor by nitrogen and argon pressure in the range of 13550...13950 cm^{-1}. The calculated relaxation parameters of H_2O lines with the measured ones were compared.

UDC 538.97:539.186:539.184

Babaev A.A., Pivovarov Yu.L.
COMPUTER SIMULATION OF RESONANT COHERENT EXCITATION OF $^{+17}$Ar IONS SUBJECT TO FINE STRUCTURE OF ENERGY LEVELS

Computer model allowing studying fine structure influence on characteristics of resonant coherent excitation of relativistic hydrogen-like ions at planar channeling was constructed. The model was used for describing resonant coherent excitation at planar channeling 390 MeV/nucleon of $^{+17}$Ar ions. It was shown that resonant curves are characterized by two closely arranged peaks stipulated by ion electron transition from the ground state to the state corresponding to the fine structure components of excited state. Rather good agreement with the experiment was obtained.

UDC 535.218:37

Tyurin Yu.I., Khoruzhiy V.D., Shigalugov S.H., Sivov Yu.A., Smekalina T.V.
EFFICIENCY OF TRANSFER OF ADSORPTION ENERGY AND ATOM RECOMBINATION TO A SOLID AT VARIOUS EXCITATION MECHANISMS

Elemental excitation mechanisms of electron (ion) subsystem of solids by atomic particles of thermal energy have been considered: ionization mechanism of electron-hole pair generation, adiabatic and nonadiabatic transitions, multiquantum vibrational-electron transition. The peculiarities of each mechanism depending on excitation conditions were determined. Analytic regularities allowing us to compare the efficiency of electron-excited state generation at various excitation mechanisms were obtained.

UDC 535.372

Lisitsyna L.A., Putintseva S.N., Oleshko V.I., Lisitsyn V.M.
SPECTRAL–KINETIC PARAMETERS OF URANIUM COMPLEXES PHOTOLUMINESCENCE IN LIF CRYSTALS

The results of researches with nanosecond time resolution of spectral-kinetic parameters of photoluminescence of crystal LiF containing uranium-hydroxyl complexes at 300 K have been presented. It has shown that irradiation of crystals by electron beam leads to the distraction these complexes and both the change of probability of emitting transitions and the relation between intensity of different bands in photoluminescence spectra in range 2,6...2,1 eV.

UDC 539.194;531.19

Ivanov I.V., Ivanov V.N.
INFLUENCE OF STEADY-STATE MAGNETIC FIELD ON MOLECULE RADIATION SPECTRUM

The oscillatory spectrum of molecules has been studied theoretically in supposition that molecules are in steady-state magnetic field. It was obtained that at stochastic perturbation in the case of low magnetic intensity the Bose condensation of oscillatory states is probable. Thus molecules stop radiating and absorbing energy in oscillatory range and become invisible in this range. Increasing field intensity the temperature of such condensation is reduced. The dependence has nonlinear character but in extreme cases of low and high magnetic intensity it becomes practically linear. At high strengths of a magnetic field the Bose condensation may completely disappear.

UDC 531.768:534.1

Tsupin A.A., Slobodyan M.S., Maslennikov V.N., Slobodyan S.M.
EVALUATION METHOD OF PIEZODEFLECTOR QUALITY

The dependence of noise of electrically excited damped vibrations of piezoelectric element on its faults has been theoretically determined. The quality evaluation method of piezoelectric deflector of laser cross section (direction indicator) in real time was suggested.

UDC 621.373.826.533.9

Shishigin S.A., Slobodyan S.M.
GLOW OF SITES OF AIR OPTICAL BREAKDOWN

The results of studying radiation dynamics of plasma formations in the air at propagation of laser emission with wave length of 10,6 mkm, microsecond duration, average intensity along beam cross-section from 10^6 to 10^9 W/cm^2 have been given; the results of analysis of interaction process of laser radiation with plasma of air optical breakdown resulting in formation of roentgen and electron radiation with track length in the air of a few centimeters and responsible for formation of gas halo NO_2 around breakdown sites have been presented.

UDC 535.21

Soldatov A.N., Vasilieva A.V.
EFFECT OF LASER RESONANCE ABLATION IN MICRO- AND NANOTECHNOLOGIES

Laser use in micro- and nanotechnologies for material ablation has been discussed. The class of lasers with high pulse repetition rate (metal vapor laser) is especially singled out. Characteristics of outlet radiation of these lasers are those that they can not only replace some kinds of lasers at ablation, but also in some cases their use allows obtaining the greatest effect at influence.

UDC 563.75:(535.3;535.182)

Haliakevich T.V., Izmailov I.V., Poizner B.N., Trukhan V.M., Shergin D.A.
SIMULATION OF STRUCTURES AND CHAOS IN GENERATOR WITH LENGTHY CRYSTAL HAVING THERMODEPENDENT OPTICAL ACTIVITY

Mathematical model of nonlinear processes – at approach of extended medium with thermodependent optical activity – for ring cavity has been introduced. Maps of dynamic regimes were calculated. Resonator and cadmium phosphide parameters favorable for confidential connection device of optical range were estimated.

UDC 519.233.5+519.246.85

Torbunov S.S.
PHYSICAL EXPERIMENT IN MATHEMATICAL SIMULATION OF DYNAMIC SYSTEMS WITH DETERMINISTIC VARIABLE PARAMETERS

Construction of regression mathematic models of nonlinear and stochastic processes in many researches is the only technique allowing obtaining adequate solution of the assigned task. Physical experiment in conjunction with analytical methods and principle of external compliment consisting in empirical simplification of problem conditions for obtaining final solution results in efficient results in various branches of science. In the given article there are three examples of its use for studying stability of two phase high-temperature jet in bounded space, in powder metallurgy and investigations of rigid body motion in resist medium.

UDC 621.373.8

Abramov D.V., Galkin A.F., Zharenova S.V., Klimovsky I.I., Prokoshev V.G., Shamanskaya E.L.
VISUALIZATION OF LASER RADIATION INTERACTION WITH SURFACE OF GLASS- AND PYROCARBON BY MEANS OF LASER MONITOR

Laser radiation influence on the surface of glass- and pyrocarbon has been observed for the first time by means of laser monitor. Glass carbon fusion was recorded. Lower threshold of glass carbon fusion was stated by output power of IAG-Nd-laser. The observation method of precipitating sublimation products of glass-and pyrocarbon on a glass substrate in real time was realized. It was stated that particles of different morphology are formed as a result of precipitation for the given materials. The reason of such difference is not clear and requires further researching. Bottom contour of laser cavity was recovered on the surface of glass carbon after laser radiation influence by means of atomic-force microscope.

UDC 536.24

Arkhipov A.G., Kuznetsov G.V., Nemova T.N., Pritvorov G.V., Rudzinsky V.P.
COAL PLASTIC DESTRUCTION WITH HIGH-TEMPERATURE PLASMA JET

The technique and results of experimental studying heat-mass-conduction processes in coal-plastic on the basis of phenolic-formaldehyde resin at the influence of high-temperature jet of nitric plasma on it have been given. The conclusions of thermomechanical mode of coal-plastic destruction accompanying by formation of fine-dispersed particles due to mechanical destruction of carbon base were made. The results allow estimating the scale of radiation heat pore transfer in carbonized coal-plastic at temperatures higher than 1500 K and intensive mechanical carry-over of material carbonized layer at temperatures higher than 2300 K.

UDC 621.373.826

Gubarev F.A., Fedorov V.F., Evtushenko G.S., Sukhanov V.B., Zaikin S.S.
COPPER BROMIDE VAPOR LASER WITH PULSE REPETITION FREQUENCY OF 400 kHz

Pulse oscillation in copper bromide vapor laser of minor active volume with pulse repetition frequency of 400 kHz has been obtained. Oscillation frequency increase was achieved by applying modulator lamp with start from high-speed pulse former in pump circuit.

UDC 621.373.8

Sukhanov V.B., Tatur V.V.
OPERATIONAL CHARACTERISTICS OF THE CuBr-LASER WITH THE TRANSISTOR SWITCHBOARD

Results of practical researches of operational characteristics of the CuBr-laser with the switchboard on bipolar transistors with the isolated shutter are resulted{brought}. The opportunity of job of a source pumping on various types CuBr-gas-discharge tubes is shown.

UDC 537.527.9,519.673

Bychkov Yu.I., Panchenko A.N., Telminov E.A., Tarasenko V.F., Yampolskaya S.A., Yastremsky A.G.
KrF*-LASER WITH DOUBLE DISCHARGE PUMP FROM GENERATOR WITH INDUCTIVE ENERGY STORAGE

The possibility of increasing duration of radiation pulse of KrF*-laser has been shown. Generator with inductive energy storage and semiconductor current interrupter was used for discharge forming. Radiation energy of 0,65 J at pulse duration at half-height of 90 ns was obtained, radiation energy efficiency relative to primary condenser energy is 1,4 %. Maximum radiation power is 8 MW at oscillation efficiency relative to pump power is 6,4 %.

Numerical investigation of laser radiation characteristics including studying plasma formation process and inverted population development was carried out. Typical electrophysical processes in laser supply circuit were considered.

Rated dependences of: pump and radiation power, electron concentration, Kr* excited atoms, F2 molecules as well as rates of ionization, recombination and adherence processes on time are presented. Good fit of calculated and experimental time dependences of discharge and laser radiation characteristics was obtained.

UDC 535:621.373.826

Zvorykin V.D., Ionin A.A., Konyashenko A.V., Kovalchuk B.M., Krokhin O.N., Losev V.F., Mesyats G.A., Mikheev L.D., Molchanov A.G., Novoselov Yu.N., Seleznev L.V., Sinitsyn D.V., Starodub A.N., Tarasenko V.F., Yakovlenko S.I.
POWERFUL FEMTOSECOND HYBRID LASER SYSTEMS WITH WIDE-APERTURE AMPLIFIERS ON THE BASES OF GAS LASERS. 1. HYBRID FEMTOSECOND KrF LASER SYSTEM

One of two multicascade hybrid laser systems generating ultrashort radiation pulses with peak power of ~10^{14}...10^{15} W created at the present time in P.N. Lebedev Physical institute of RAS has been discussed. This system is based on amplification of femtosecond pulses at wave length of 248 nm (third harmonic of Ti:Sa-laser) in active medium of electron-beam KrF laser amplifier. The final cascade of laser system is electron-beam device with laser chamber with the diameter of 60 cm and length of 200 cm. Parameters of such device pump are close to laser parameters having developed earlier in the Institute of high-current electronics of RAS SD: electron energy is ~600 keV, pump specific power is ~300...500 kW/cm^3, pulse duration of electron beam is ~100...200 ns. The possibility of applying Kr_2F molecules as an active medium with saturation energy of 0,2 J/cm^2 for amplifying ultrashort pulses was also considered. It was shown theoretically that laser pulse output energy of final KrF of amplification stage may achieve ~17 J at pulse duration of ~50 fs. Ti:Sa laser system generating ~50 fs pulses with energy of 0,5 mJ at wave length of 248 nm was developed and set in P.N. Lebedev Physical institute of RAS. Preliminary experiments on amplifying UV femtosecond pulses in electric discharge KrF laser amplifier were carried out.

UDC 535:621.373.826

Zvorykin V.D., Ionin A.A., Konyashenko A.V., Kovalchuk B.M., Krokhin O.N., Losev V.F., Mesyats G.A., Mikheev L.D., Molchanov A.G., Novoselov Yu.N., Seleznev L.V., Sinitsyn D.V., Starodub A.N., Tarasenko V.F., Yakovlenko S.I.
POWERFUL FEMTOSECOND HYBRID LASER SYSTEMS WITH WIDE-APERTURE AMPLIFIERS ON THE BASES OF GAS LASERS. 2. HYBRID FEMTOSECOND XeF(C-A) LASER SYSTEM

One of two multicascade hybrid laser systems generating ultrashort radiation pulses with peak power of ~10^{14}...10^{15} W created at the present time in P.N. Lebedev Physical institute of RAS has been discussed. This system is based on amplification of femtosecond pulses at wave length of 480 nm (the second harmonic of Ti:Sa-laser) in medium of photochemical XeF(C-A) laser with pump of electron-beam Xe_2 lamp with VUV radiation. The final cascade of laser system is electron-beam device with laser chamber with the diameter of 30...40 cm and length about 2 m. Parameters of such device pump are close to those of laser having developed earlier in the Institute of high-current electronics of RAS SD: electron energy is ~600 keV, pump specific power is ~300...500 kW/cm^3, pulse duration of electron beam is ~100...200 ns. It was shown theoretically that laser pulse output energy of final amplification stage may achieve ~75 J at pulse duration of ~25 fs. Ti:Sa laser system generating ~50 fs pulses with energy of 4 mJ at wave length of 480 nm was developed and set in P.N. Lebedev Physical institute of RAS.

UDC 537.533.2

Baksht E.H., Burachenko A.G., Lomaev M.I., Rybka D.V., Tarasenko V.F., Khrush E.A.
ELECTRON BEAM GENERATION IN NITROGEN AND HELIUM AT LOW STRESS ON GAS DIODE

It was demonstrated experimentally that the beam of runaway electrons is generated at discharge ignition in nitrogen and helium atmosphere at low voltage on gas diode (~25 kV) and generation modes may be various and depend on gas pressure. Delay of starting electron beam generation relative to voltage drop start at a gap was less than 1 ns. On the basis of influence of crosscut magnetic field 0,016 T on electron beam behavior it was supposed that nanosecond electron beam at low pressures is generated near the cathode. Influence of preionization on electron beam generation was shown.

UDC 537.523.9

Kostyrya I.D., Lomaev M.I., Tarasenko V.F., Rybka D.V., Baksht E.H.
ON SPACE DISTRIBUTION OF ELECTRON FLOW AT GENERATION OF ULTRASHORT AVALANCHE ELECTRON BEAM IN GAS DIODE

Space distribution of runaway electrons and *x*-ray generated in gas diode at supplying nanosecond pulses of high voltage has been studied. It was shown that in gas-filled diode (air at pressure of 1 atm) with sharply inhomogeneous electric field the ultrashort (<100 ps) avalanche electron beam is generated into solid angle more than 2π stera-

dian. Decreasing the gap d between cathode and anode results in decreasing beam current amplitude generated to the side walls of gas diode. Beam current to gas diode side wall is registered by the collector installed perpendicularly to gas diode axis and at low gaps (d=8 mm).

UDC 537.523

Baksht E.H., Erofeev M.V., Lomaev M.I., Rybka D.V., Sorokin D.A., Tarasenko V.F.
OSCILLATION OF ULTRASHORT AVALANCHE ELECTRON BEAM IN INSULATING GAS

Formation of ultrashort (100...2500 ps) avalanche electron beam in insulating gas (SF6) at pressures 0,1...2,5 atm has been studied. Electron beam was obtained at insulating gas pressure in gas diode up to 2 atm behind foil AlBe with thickness of 45 mkm. It was shown that at increased pressures (>1 atm) and supplying high voltage nanosecond pulses (270 kV) from generator the pulse duration of utrashort avalanche electron beam at half-height increases up to 150 ps.

UDC 548.30

Atuchin V.V., Gavrilova T.A., Kokh K.A., Pokrovskiy L.D., Surovtsev N.V.
MICROMORPHOLOGY OF $AgGaS_2$ MONOCRYSTALS

$AgGaS_2$ monocrystals have been grown by Bridgman method in the conditions of thermal field conditions. The obtained crystals are characterized by significant light scattering owing to the «fog» effect. Extractions with typical sizes of 50...100 nm were revealed in the volume of grown crystal by the method of scanning electron microscopy. Polycrystalline state of mechanically polished surface of $AgGaS_2$ was stated by diffraction method of reflection high energy electrons. The revealed impurities were removed by continuous high-temperature crystal processing in Ag_2S vapors. Complete similarity of Raman spectra for grown and additionally thermally treated crystals of $AgGaS_2$ was stated.

UDC 621.373.826.038.823

Dudarev V.V., Kotov Yu.A., Losev V.F., Panchenko Yu.N., Samatov O.M.
STUDYING CONDITIONS OF CeGdO NANOPOWDER OBTAINING BY EXCIMER LASER RADIATION

Efficiency of obtaining CeGdO nanopowder the influencing by XeCl laser radiation on solid-state sample of CeO_2/Gd_2O_3 has been studied. It was shown that increasing pumping energy density higher than optimal one the efficiency of nanopowder formation decreases owing to rising screening properties of laser plasma. Optimal range of radiation energy densities for interaction with sample surface which amounted to 40...90 J/cm^2 was determined.

UDC 541:537.523:66.011

Boganov S.E., Kudryashov S.V., Ryabov A.Yu., Klimkin V.M., Klimkin A.V., Egorov M.P., Nefedov O.M.
STUDYING METHANE AND CYCLOHEXANE CONVERSION IN GLOW AND MICROWAVE DISCHARGES BY TECHNIQUE OF MATRIX INFRARED SPECTROSCOPY

The comparative investigation of products occurring in glow and microwave discharges in argon containing little admixtures (0,5...1 mole %) of methane and cyclohexane without and with oxygen additives (up to 2 mole %) at pressure of ~10^{-1} Pa has been carried out by the technique of matrix infrared spectroscopy. As a result of investigation a number of stable and instable electro neutral intermediates was stated. On the basis of the obtained results the conclusions of single reactions with methane and cyclohexane in cold plasma conditions at low pressure were made. In particular, methane decay reversibility in cold plasma conditions and cyclohexane tendency to cycle decay was shown and illustrations of nonradical formation mechanism of lower alkenes and olefin from cyclohexane in these conditions were obtained.

UDC 621.39

Bunin S.V., Sonkin M.A., Harlamov A.M., Yampolskiy V.Z.
NEW FUNCTIONALITY OF THE WARNING SYSTEM AND RESERVE DOCUMENTARY CONNECTION OF THE INTERNAL TROOPS OF RUSSIAN INTERIOR MINISTRY

Reviewed are the new functional abilities of the warning system and reserve documentary connection of the Internal troops of Russian Interior Ministry, called to meet the increased requirements of well-timed reliable and confidential information. High functionality, cohesion and survivability of the reserve system is provided on the basis of integration of different channel types and channeling equipment, using the up-to-the-minute microprocessor technologies, optimization of systems engineering solutions at constructing the hardware and software communicational equipment, implementation of special software supporting enhanced mobility, reliability and operating benefits.

UDC 621.39

Sonkin M.A., Yampolskiy V.Z.
GENERALIZED CHARACTERISTICS OF SPECIAL COMMUNICATION AND MONITORING SYSTEMS FOR REMOTE AND MOBILE OBJECTS

Reviewed are such characteristics of special communication and monitoring systems as: state of distribution, hierarchical arrangement, multitasking functionality, stratification, integrated management and multicoupling. The analysis of these characteristics provide considerable increase of its efficiency at the stage of design or upgrade.